

# Larval morphology, habitat and distribution of *Limnephilus diphyes* (Trichoptera, Limnephilidae)

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Based on material from northern Sweden the larva of *Limnephilus diphyes* McLachlan, 1880, is described for the first time. Within the genus, larvae of this species are characterized by their dorsoventrally flattened case with dorsal and ventral series of semicircular leaf or bark fragments. *L. diphyes* larvae inhabit small moss or detritus pools on bogs. Larvae of instars III–V were found from May to September with emergence of adults in late June. An ichneumonid (Hymenoptera) larva was found in a pupal case together with the empty skin of the eaten pupa. The Fennoscandian records of *L. diphyes* are mapped.

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## Introduction

*Limnephilus* larvae are abundant in most boreal aquatic biotopes, and 40 species have been recorded in Sweden (Gullefors 1988). Very little is known concerning larval morphology and habitat utilization of several species, especially the northern ones. Larval descriptions are still lacking for ten of the Swedish *Limnephilus* species, a fact that makes identification hazardous. The most inclusive European identification key is the one given by Wallace et al. (1990), in which only 12 of the Swedish species are not considered. Larvae of two additional species are described by Gislason (1979). Larval morphology in the genus *Limnephilus* is rather diverse. Moreover, no diagnostic character is found which separates the genus from the North European limnephilid genera *Asynarchus*, *Colpotaulius* and *Phacopteryx*. However, combinations of characters allow the identification of most *Limnephilus* species. This is also true for *Limnephilus diphyes* McLachlan, 1880, a species that deviates from all its known congeners in the structure of the case.

## Material and methods

Twenty small detritus or moss pools located to a fen on the large bog Isovuoma (66°35'N 23°10'E)

a few km N of Jänkisjärvi and the Arctic Circle in the province Norrbotten in northern Sweden were studied. This area belongs to the North Boreal vegetation zone (Ahti et al. 1968) dominated by forests of Norway spruce and Scots pine. *Betula pubescens* is common between pools, and the ground is largely covered with *Sphagnum* moss and *Eriophorum vaginatum* L., *Ledum palustre* L., *Vaccinium* sp. etc on tussocks (Fig. 1).

The pools were visited eight times from 22 May to 30 September 1990. On each occasion, net samples were taken to collect aquatic macroinvertebrates and water temperature (5 cm below surface at pool center) and pool depth were measured. For caddis larvae and pupae, only presence was noted and selected specimens were preserved in alcohol.

*L. diphyes* pupae and larvae in instars III–V were found in 13 pools. Eight mature larvae or pupae collected alive were reared to adults in the laboratory. Two additional larvae were collected in a similar pool near Maltträsk (64°37'N 19°00'E) in the Västerbotten province on 19 August 1990. Larvae were assigned to instar from head width and metatibia length (along dorsal margin) measurements (Fig. 2). The description is based on 21 larvae in instar V, 9 in instar IV, and 4 in instar III. Characters refer to instar V if not otherwise stated. The morphological termino-



Fig. 1. Detritus pool inhabited by *Limnephilus diphyes* McLachlan at Jänkisjärvi in northern Sweden. Photo: B.W. Svensson.

Detrituspool med larver av *L. diphyes* i björksumpskog på myr vid NB: Jänkisjärvi.

logy follows Wiggins (1977), with setal areas on meso- and metanotum coded as: sa1 (anterior), sa2 (posterior) and sa3 (lateral). Measurements are given as mean  $\pm$  SD when possible.

## Description

**Body length.** 12–17 mm in instar V, 9–11 mm in instar IV, 5.5–7 mm in instar III.

**Colour.** Head dark brown with V-shaped brownish yellow pattern along frontoclypeal suture (Fig. 3); neck and area ventrally of stemmata paler; labrum reddish brown, medially brown. Pro- and mesonota brown with posterior marginal beads blackish brown. Metadorsal sclerites greyish brown. Prosternite pale yellowish brown. Dorsal sclerite of abdominal segment 9 and lateral sclerite of anal proleg yellowish grey with small darker spots basally; anal proleg claw reddish yellow. Legs rufotestaceous with coxae slightly darker.

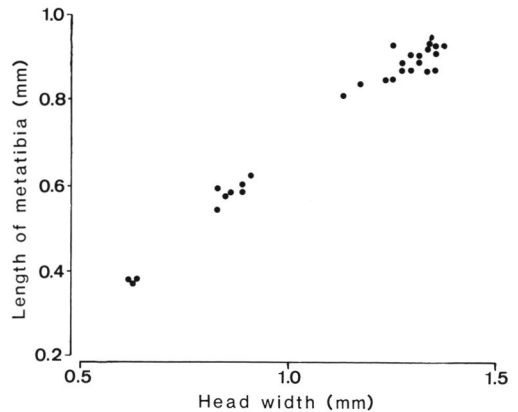


Fig. 2. Relationship between length of metatibia and head width in larvae of *Limnephilus diphyes* McLachlan. Clusters represent instars III–V.

Förhållande mellan baktibiens längd och huvudets bredd hos de studerade larverna. De tre grupperna representerar stadierna III–V.

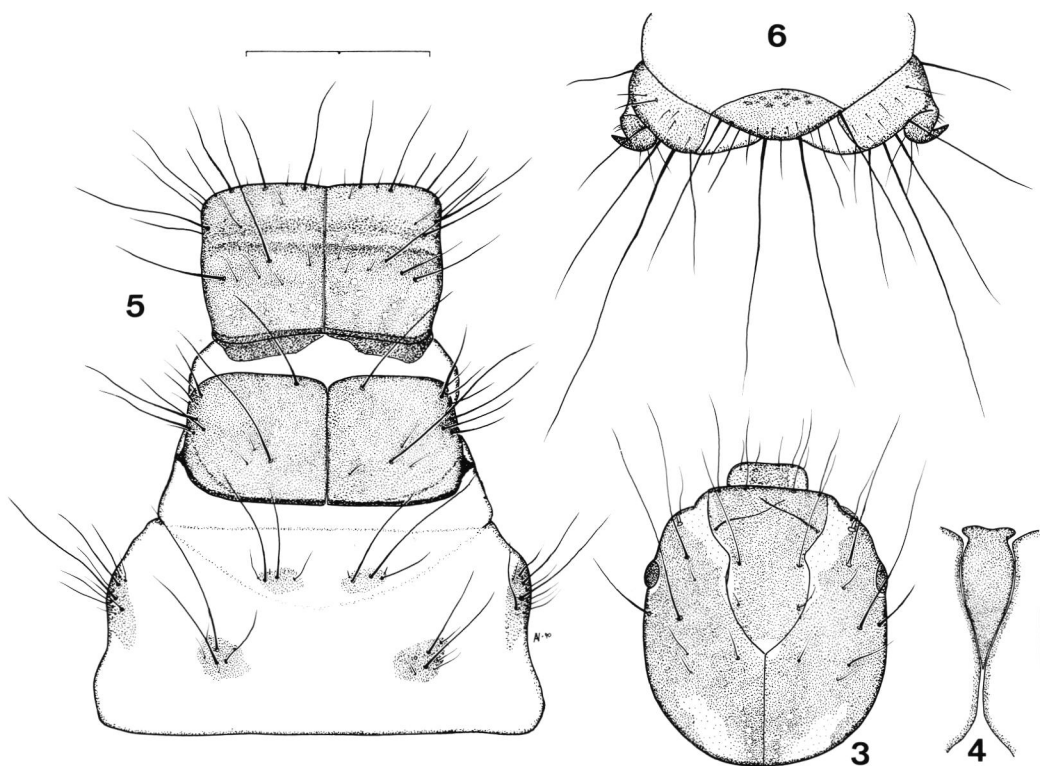
**Head** (Fig. 3). Maximum width 1.13–1.35 mm ( $\bar{x} = 1.29 \pm 0.07$  mm,  $n = 13$ ) in instar V, 0.83–0.91 mm ( $\bar{x} = 0.87 \pm 0.03$  mm,  $n = 7$ ) in instar IV, 0.61–0.64 mm ( $\bar{x} = 0.62 \pm 0.01$  mm,  $n = 4$ ) in instar III. Dorsum with primary setae only. Labrum with six pale setae along anterior margin and four darker setae on disc. Ventral apotome longer than postgenal suture (Fig. 4).

**Pronotum** (Fig. 5). Anterior margin with 12 long and about 8 short setae. Transverse median setal row with 4 long and 8 short setae. Proventer without lateral sternites.

**Mesonotum** (Fig. 5). sa1 with single long seta, sa2 with 1 long and 2 or 3 short setae, sa3 with 4 long and 4–6 short setae.

**Metanotum** (Fig. 5). Setal areas sclerotized; sa1 and sa2 with 2 long and 2–4 short setae, sa3 with 4 long and 6 short setae.

**Abdomen.** Segments 2–7 with 1–3 lateral tubercles on each side. Chloride epithelia present ventrally on segments 4–7. Tracheal gills present on segments 2–7 with number of filaments as in Tab. 1. Anterolateral gill on segment 2 rarely absent. Segment 1 dorsally with 1 long and 1 short seta in sa1, 2 long and 1 short setae in sa2, 3 long and 3 or 4 short setae in sa3; ventrally with a single seta in each of sa1 and sa3, and 3 long and 3 short setae in sa2. Segment 8 dorsally with continuous transverse row of 2 long and 10–12 short setae.



Figs 3–6. *Limnephilus diphyes* McLachlan, fifth-instar larva. –3. Head, dorsal view. –4. Ventral apotome of head, ventral view. –5. Thorax, dorsal view. –6. Tip of abdomen, dorsal view. Different scale bars for 3, 5, 6 (upper left 1 mm), and 4 (lower right 0.5 mm).

Fullväxt larv. –3. Huvud uppifrån. –4. Gularsklerit underifrån. –5. Mellankropp uppifrån. –6. Bakkroppsspets uppifrån.

Dorsal sclerite of segment 9 with 4 long and about 10 short setae (Fig. 6). Claw of anal proleg with 1 large and 2 or 3 small accessory teeth.

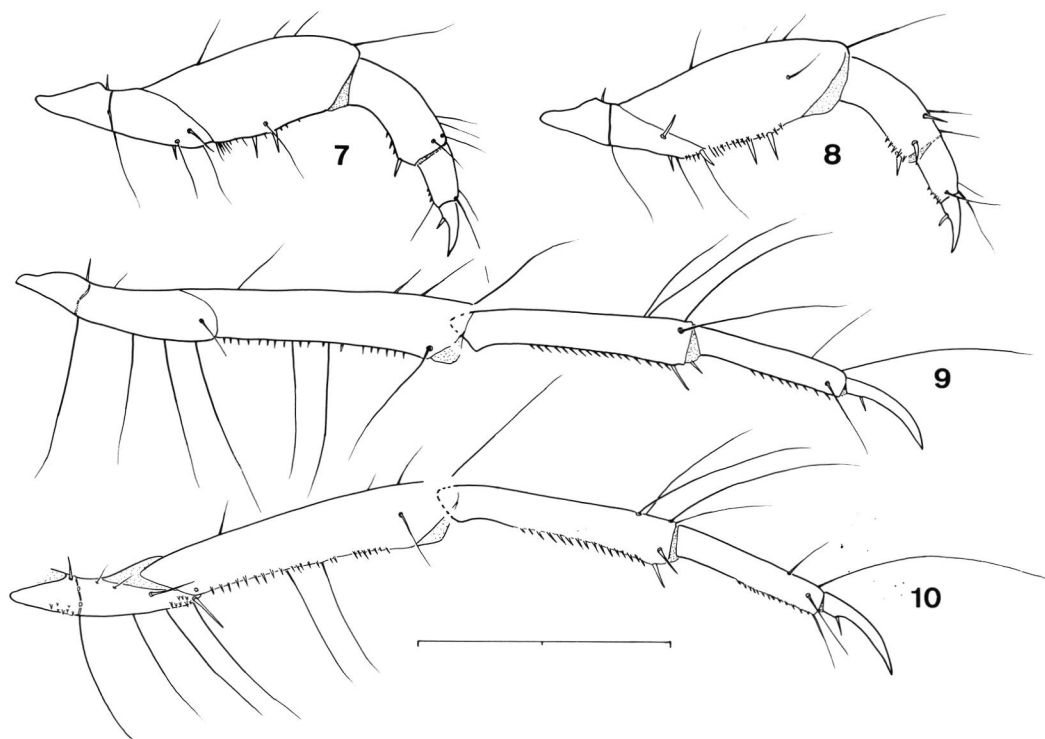
**Legs** (Figs 7–10). Tarsal claw with basal seta short. Each tarsus and tibia with primary setae only. Each femur with 1 or 2 additional dorsal setae in distal half. Profemur with both ventral spiniform setae yellow. Meso- and metafemora with both ventral setae long and black. Each trochanter without ventrodistal setal brush or additional setae on proximal section. Meso- and metatrochanters with 2 or 3 additional setae on anterior face between pale primary setae (Fig. 10).

**Case** (Fig. 11). Dorsoventrally flattened; ventral and dorsal layers of semicircular fragments of dead leaves (chiefly *Betula*) or bark attached to central tube. Dorsal layer normally protruding an-

Tab. 1. Number of filaments in tracheal gills on abdominal segments 2–7 of instar V larvae of *Limnephilus diphyes* McLachlan. Positions abbreviated as: (A) anterior, (D) dorsal, (L) lateral, (P) posterior, and (V) ventral.

Gill	Segment					
	2	3	4	5	6	7
AD	3	3	3	2	1–3	1–2
PD	3	3	3	2	2	1
AL	3	3	1–2	0	0	0
PL	2–3	1	0	0	0	0
AV	3	3	3	2–3	2	1–2
PV	3	3	3	3	2	2

teriorly. Total length 15–21 mm ( $\bar{x} = 18.5 \pm 1.9$  mm,  $n = 13$ ) in instar V, 11–16 mm ( $\bar{x} = 12.3 \pm 1.9$  mm,  $n = 6$ ) in instar IV and 5.5–9 mm in instar III. Maximum width 6–9.5 mm ( $\bar{x} = 7.4 \pm 1.0$  mm,



Figs 7–10. *Limnephilus diphyes* McLachlan, fifth-instar larva, leg without coxa. –7–8. Fore leg. –9–10. Mid leg. –7, 9. Posterior aspect. –8, 10. Anterior aspect. Scale bar 1 mm.

Fullväxt larv, ben utan höft. –7–8. Framben. –9–10. Mellanben. –7, 9. Bakifrån. –8, 10. Framifrån.

$n = 13$ ) in instar V, 4.5–6 mm ( $\bar{x} = 5.3 \pm 0.5$  mm,  $n = 6$ ) in instar IV, and 3.5–4 mm in instar III.

### Comparison with other species

In Wiggins' (1977) key to larvae of Nearctic genera of Limnephilidae, *L. diphyes* will key out as *Nemotaulius* because of the single seta in mesonotal sal. However, larvae of *L. diphyes* differ from those of the single European species of the genus, *N. punctatolineatus* (Retzius), in the absence of additional setae on anterior and posterior faces of meso- and metafemora and in the colour pattern of the head (no yellowish base colour with a dark U-shaped band extending through each eye, and no central longitudinal dark band on the frontoclypeal apotome).

In the key to larvae of British and Irish species of Limnephilidae presented by Wallace et al. (1990), *L. diphyes* larvae will run to couplet 71,

where the head width range spans both alternatives. Choosing a head width more than 1.20 mm will lead to the last couplet (78) in which no alternative fits as the head of *L. diphyes* has pale areas around the edges of the frontoclypeal apotome like *L. binotatus* Curtis, but the ventrodistal spinulae on the meso- and metatrochanters are dagger-like as in *L. elegans* Curtis. Furthermore, the case of *L. diphyes* is different from those of both these species.

In Hiley's (1976) key to British species, *L. diphyes* larvae will key out as *L. elegans*. This species has a cylindrical case and the head lacks the lateral pale bands along the frontoclypeal suture.

### Distribution

*Limnephilus diphyes* was first described from arctic Siberia at the Yenesei (McLachlan 1880: xxiv). The distribution was soon expanded to Finland

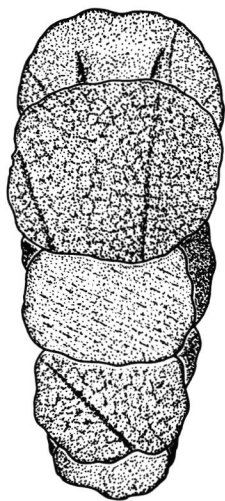


Fig. 11. *Limnephilus diphyes* McLachlan, case of fifth-instar larva, ventral view. Length 18 mm.

Hus till fullväxt larv, underifrån.

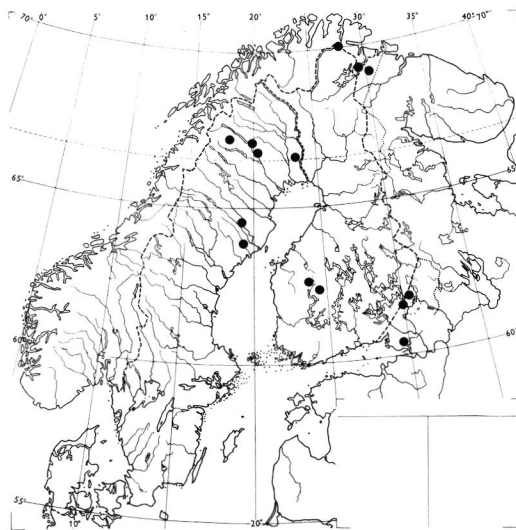


Fig. 12. Known records of *Limnephilus diphyes* McLachlan in Fennoscandia.

Kända fyndlokaler i Fennoskandien.

(Nybom 1960). Forsslund (1930) provided the first records from Sweden, and the only subsequent records from Sweden were presented by Tobias (1969:92), the typical habitat consists of small forest ponds that become choked up with vegetation. However, this observation was only based on nearby light-trap collecting (Müller, pers. comm.).

The above-mentioned Fennoscandian records are shown in Fig. 12 together with our records from Malträsk and Jänkisjärvi. Our records are the first ones from the provinces of Västerbotten and Norrbotten, respectively.

### Habitat

Very little information has been published on the habitat of *L. diphyes* larvae. According to Tobias (1969:92), the typical habitat consists of small forest ponds that become choked up with vegetation. However, this observation was only based on nearby light-trap collecting (Müller, pers. comm.).

*L. diphyes* larvae or pupae were found in 13 out of 20 pools studied near Jänkisjärvi. These pools had a basin area from 0.1 to 1.1 m<sup>2</sup>, and the maximum depth ranged from 0.13 to 0.43 m. Pool bottoms were covered by a mixture of detritus (chiefly *Betula* leaves) and *Sphagnum* moss. The moss cover ranged from a marginal fringe to al-

most the entire basin. The water was brown due to humic acids. Water temperatures (Fig. 13) differed between pools. On each occasion, the temperature of the warmest pool was about 5°C warmer than that in the coldest pool. Mean temperature peaked at 16°C in early August, when the warmest pool was 18.2°C. Most pools carried water at all visits, but 4 pools were completely dry on 4 July.

Larvae of *L. coenosus* Curtis were found in all 20 pools studied, while those of *Rhadicleptus alpestris* (Kolenati) were rare and only found in 4 pools. Mosquito larvae developed in all pools, and *Aedes communis* (De Geer) was the most frequent species. Chironomid larvae were also abundant. Dytiscids were the chief predators, and 15 species were recorded. The most common dytiscids included: *Hydroporus morio* Aubé, *H. melanarius* Sturm, *H. tristis* (Payk.), *H. brevis* F. Sahlb., *Agabus elongatus* (Gyll.), *A. lapponicus* (Thoms.) and *A. wasastjernae* (C. R. Sahlb.).

### Biology

At Jänkisjärvi, *L. diphyes* larvae in instars III-V were present during most of the summer, from late May to late September. Mature larvae were collected in late May, early June and late September. Pupae were found from 22 May to 4 July.

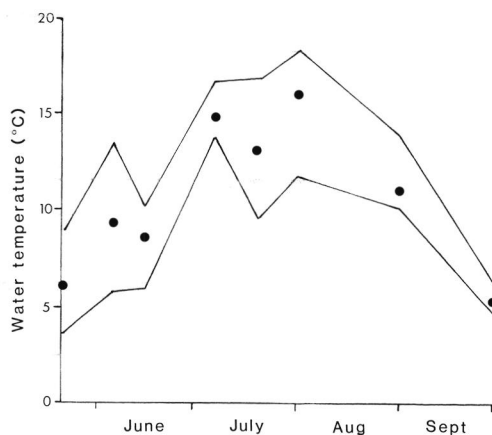


Fig. 13. Water temperature in 13 pools at Jänkisjärvi where *Limnephilus diphyes* McLachlan larvae were found. The upper line denotes the warmest pool on each occasion, and the lower line denotes the coldest pool. Dots given for mean values.

Vattentemperatur i 13 pölar vid NB: Jänkisjärvi med förekomst av *L. diphyes* sommaren 1990. Strecken visar kallaste resp varmaste pöl vid varje tillfälle och prickarna anger medelvärden.

The mature larvae and pupae collected on 22 May and 6 June produced adults from 19 to 28 June when kept in an unheated room. Tobias (1969) recorded adults on the wing in late June and early July. As we never observed larvae in instars I or II, the life cycle is incompletely known.

Pupation took place in the larval case, and the openings were plugged with pieces of *Sphagnum* stems. The case of a mature larva collected on 30 September also had the openings plugged. In a pupal case collected on 20 July a mature ichneumonid (Hymenoptera) larva was found together with an empty pupal skin.

## Discussion

The larval case of *L. diphyes* has a unique structure within the genus. However, in northern Europe, *Glyptotaelius pellucidus* (Retzius), *Nemotaelius punctatolineatus* and young larvae of *Potamophylax* have similar cases. *G. pellucidus* is similar to *L. diphyes* also because of its dark head. However, the presence of additional setae on the anterior and posterior faces of meso- and metafemora, and the differently coloured primary ventral setae of profemur separate *Glyptotaelius* larvae from those of *L. diphyes*.

The low number of previous Swedish records of *L. diphyes* suggest that it is a rare species. However, it is likely that it has been overlooked because the very special larval habitat is not likely to be searched by entomologists. This alternative is supported by our experience. Thus larvae were easily found in Västerbotten once pools similar to those at Jänkisjärvi were searched. Consequently, *L. diphyes* may well have a continuous northern Holarctic distribution.

It seems probable that *L. diphyes* at Jänkisjärvi was parasitized by the ichneumonid *Sulcarius biannulatus* (Graw.) (Siltala & Nielsen 1906, as *Hemiteles biannulatus*). A wasp of this genus was reared from pupal cases of *L. coenosus* collected near Umeå in winter (T. Olsson unpubl.). At Jänkisjärvi, we found an empty pupal case of *L. coenosus* with a small circular (exit?) hole that probably was made by the same ichneumonid species. Apparently, this parasitoid has both *L. coenosus* and *L. diphyes* as hosts at this site. The identity of the *Sulcarius* species involved is uncertain as there are at least three species of the genus in Fennoscandia (L. Hedström, in litt.).

**Acknowledgements.** B. Gullefors, Forsed, kindly checked our identification of adults. R. Danielsson, Lund, provided information from the late K.-H. Forsslund's notebooks. K. Müller, Hörnefors, gave us details of the Messaure records. C. Otto, Umeå, and P. Wiberg-Larsen, Odense, gave comments on the manuscript. Thanks also to T. Olsson, Umeå, for information on *Sulcarius* wasps, kindly identified by L. Hedström, Uppsala.

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## Sammanfattning

Larven av den nordliga och sällsynta nattsländan *Limnephilus diphyes* McLachlan beskrivs för första gången. Strukturen på larvens hus är unik för *Limnephilus*, även om likartade hus återfinns hos några närstående släkten. Larverna utvecklas i små moss- och detritusgölar på myrar. En utbredningskarta ges för Fennoskandien, och arten anmäls från Västerbotten och Norrbotten.

## Bertil Lekander in memoriam

Den 7 juni 1990 avled professor emeritus i skogsentomologi Bertil Lekander efter en längre tids sjukdom. Bertil Lekander var född den 30 december 1915 i Stockholm. Han tog studentexamen 1935 vid Normalmals Högre latinläroverk, blev hösten 1939 filosofie kandidat vid Stockholms högskola och disputerade 1949 för filosofie doktorsgrad med en avhandling över huvudets sidolinjesystem och täckben hos vissa benfiskar.

Lekanders tidiga arbeten vid Stockholms högskola gällde vertebratanatomi. 1949 anställdes han vid Statens skogsforskningsinstitut, som senare uppgick i Skogshögskolan (nu Sveriges lantbruksuniversitet), och arbetade sedan dess helt på skogsentomologins område. Därvid använde han sina gedigna kunskaper i anatomi, histologi och mikroskopisk teknik för grundläggande undersökningar över barkborrars inre byggnad. Detta förde honom in på morfologiska och taxonomiska studier, som bl a resulterade i det stora arbetet "Scandinavian Bark Beetle Larvae" (1968). Dessa studier har fått stor internationell uppmärksamhet.

Bertil Lekanders entomologiska produktion, som omfattar ca 100 skrifter, behandlar många grundläggande och tillämpade skogsentomologiska frågor. Han ägnade särskilt intresse åt barkborrar och andra skalbaggar som angriper levande träd eller virke. Hans arbeten utmärker sig genom noggranna analyser och försiktiga slutsatser.

Bertil Lekander hade ett starkt intresse för nordiska frågor och var en av de drivande krafterna inom det nordiska skogsentomologiska samarbetet. Han bidrog till flera gemensamma undersökningar och publikationer, t ex som huvudförfattare för "The Distribution of Bark Beetles in the Nordic Countries" (1977). Han var under många år ledamot av samarbetsnämnden för nordisk skogsforskning, ett organ under Nordiska ministerrådet.

De som har samarbetat med Bertil Lekander minns honom som en lugn och vänlig människa med en underfundig humor, en hjälpvillig och pålitlig kamrat och forskarkollega.

H. H. Eidmann